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USSR Report

ENGINEERING AND EQUIPMENT

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USSR REPORT

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UDC 629.125.8.014.51-52:533.693

AUTOMATION SYSTEM FOR IMPROVING SEAWORTHINESS AND MANEUVERABILITY OF HYDROFOIL VESSELS

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 83 pp 28-29

MALOFEYEV, V. Ye., SHLEYENKOV, I. F. and YANCHEVSKIY, E. A.

[Abstract] An automatic stabilization and control system is considered for hydrofoil vessels which will improve not only the seaworthiness of such sea vessels as "Kometa" and "Vikhr'" but also their maneuverability. Its principle is based on localizing the wave perturbations by adjusting the angles of attack of the underwater foils. It should then be also possible to shorten the vessel's acceleration (deceleration) time and distance while reducing the demand on the vessel's main power plant. The automatic control system is designed to facilitate a programmable ascent onto hydrofoils, to facilitate turns along a curvilinear course, and to reduce tilt, draft, and course fluctuations, with comfort of passengers and crew taken into consideration. Results of calculations based on a simple mathematical model indicate the performance of a vessel with such an automatic control on rough sea (point 4 on the swell scale). Relative to vessel without this automatic control, rocking amplitude and acceleration at the center of mass are reduced on the average to one half and yaw is reduced to one tenth. Figure 1, table 1, references 3 Russian.
[44-2415]

UDC 629.12.037.001.24

DIMENSIONAL DESIGN OF FRAMING AND SHEATHING FOR FIXED PROPELLER NOZZLES

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 83 pp 9-11

BRONSKIY, A. I.

[Abstract] On the basis of extensive studies pertaining to installation of propeller nozzles in large ships, design formulas have been developed for

calculating the dimensions of their frames and sheaths. These formulas are derived essentially from a stress analysis and yield dimensions necessary to ensure adequate performance under pulsating loads, under hydrostatic and hydrodynamic water pressures, also under lateral pressure during evolutions of the ship. The inner sheath is particularly critical, especially when made of a corrosion-resistant material. Welding seams are designed to ensure adequate strength and reliability. Thickness calculations are made with allowance for erosion. Figures 4, references 5: 3 Russian, 2 Western. [44-2415]

UDC (621.311.25:621.039):621.165-57

RESULTS OF STARTUP ADJUSTMENT WORK DONE ON TURBINE EQUIPMENT IN 440 MW POWER UNIT WITH VVER-440 WATER-MODERATED WATER-COOLED POWER REACTOR

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 83 pp 12-15

FINKEVICH, V. A., engineer, YURCHISHIN, I. V., engineer, DROGOMERETSKIY, S. S., engineer, and DZHALO, V. F., engineer, Southern Regional Engineering Administration of Power Systems

[Abstract] The 440 MW power unit in the Rovenskiy AES consists of a VVER-440 water-moderated water-cooled power reactor and two K-220-44/3000 turbine-generator sets. Its thermal system consists of two stages, the first around the reactor including six steam generators (water at 270-300°C and 125-140 kgf/cm^2, dry saturated steam at 260°C and 47 kgf/cm^2) and six circulation loops, the second around both turbine-generator sets almost analogous to one in a fossil-fuel plant but also including a separator and a superheater for the high-pressure cylinders. During installation there has been work done on startup adjustment which involved rerouting of the condensate pipes, isolation of the steam drainage pipes, insertion of a regulator valve into the condensate dumping line, addition of an auxiliary drainage on the live-steam side, and addition of bypasses around the return valve so as to allow pressurization of the condensate pumps. A common collector was installed for supplying all deaerators, ejectors, and turbine seals with 13 kgf/cm^2 steam during startup. The performance of the unit was checked after these modifications and all components were found to operate satisfactorily. Moreover, vibration of pipes during transients in the system was eliminated by not tapping through a common line the condensate of heating steam at different potentials. All this ensures the feasibility of long turbine operation under nominal load without restrictions, with a reliable and economical second thermal stage. Figures 3.
[45-2415]

UDC 621.311.25:621.039

SEPARATION CHARACTERISTICS OF DRUM-TYPE SEPARATOR MODEL FOR RBMK-1500 GRAPHITE-WATER CHANNEL REACTOR

Moscow TEPLOENERGETIKA in Russian No 9, Sep 83 pp 40-44

KARASEV, V. B., candidate of technical sciences, NOVOSEL'SKIY, O. Yu., candidate of technical sciences, ILYUSHIN, V. F., engineer, LETNITSKIY, Yu. A., engineer, LIBROVSKIY, V. B., engineer, SAKOVICH, Ye. V., engineer, SHMELEV, V. Ye., engineer, YESHCHERKIN, V. M., engineer, and SHCHEPETIL'NIKOV, V. A., engineer

[Abstract] On the basis of successful operation of AES with RBMK-1000 MW graphite-water channel reactors, reactors of this type with the same core dimensions but a 50% higher power rating are being installed in the Ignalina AES. An important item contributing to higher performance capabilities is an efficacious steam-water separator. A model of this device, the SP-2100 in-house drum-type separator has been designed and built for performance testing and evaluation. It comprises a horizontal cylindrical vessel, inside diameter 2600 mm and length 4500 mm, with two elliptical ends and two vertical barriers enclosing a 2400 mm long active space. It contains a perforated horizontal plank under the top for intake of steam, a perforated horizontal plank above the center in steam, and in the lower part a box with solid lateral walls and perforated ceiling around diffusers for water drainage and a water collector. Its design is based on but departs appreciably from that of the drum-type separators operating in the Kursk and other AES. Its performance characteristics were tested with the aid of isotope tracers, salts of ^{24}Na. The objects of measurements were quality as function of water level (mass) above the lower plank, at various steam loads and water rates, of steam wetness distribution over the separator space, steam pressure in the drum and in the outlet pipes, saturated-steam rates at the inlet to the test stand, at the inlets to steam-water mixers, and at the outlet from the separator, feed-water rate, water rate in water-steam mixer, water rate from test stand to reactor, and temperature in the lines to level meters. The results cover the performance at 87-127% nominal steam loads and 50-170% nominal water rates, with water levels of 20-400 mm above the lower plank and steam pressures of 6.0-7.0 MPa. They indicate that under a nominal steam load the maximum allowable steam wetness is equivalent to 320 mm above the lower plank in the SP-2100 model and, therefore, the water level in a standard drum-type separator can be raised 100 mm higher with an attendant improvement of the steam quality by allowing 15% more water to be extracted. Figures 4, table 1, references 2 Russian. [46-2415]

UDC 662.997

ECONOMICS OF INSTALLATION OF SOLAR HEATING PLANTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 5, May 83 (manuscript received 23 Mar 82) pp 147-151

POPEL', O. S., FRID, S. Ye. and SHPIL'TAYN, E. E., Moscow

[Abstract] An engineering-economic analysis of solar heating plants for determination of their cost effectiveness involves calculating the maximum economically feasible extra capital investment on their installation and calculating the fraction of the total heat demand covered by such a plant which will make replacement of a conventional heating plant maximally economical. The first part of the analysis is tackled here by calculating the annual economic effect of solar heating, in terms of normalized cost differential, as criterion for its competitiveness with conventional heating. The second part of the analysis is tackled here on the basis of plant performance characteristics, namely dependence of both the percent demand coverage and the annual cost differential on the area of solar radiation collectors. An analysis of the cost equation, assuming that the extra fixed cost is proportional to the collector area, reveals the necessary and sufficient condition for existence of a positive economic effect (decrement of annual operating cost). It also yields the range of its existence as well as the location (size of collector area) and magnitude of its peak, if it exists. Calculations are refined by considering that the percent demand coverage remains proportional to the collector area within the range of small areas and asymptotically approaches 100 within the range of very large collector areas. Account must also be taken the collector efficiency and thus technological as well as geographical factors. Figures 4, references 2 Russian.
[56-2415]

UDC 621.787.4:621.921.34

IMPROVEMENT OF SURFACE PLANING WITH DIAMOND TOOL

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 59-61

MIKHAYLOV, A. A., doctor of technical sciences, PLESHAKOV, V. V., candidate of technical sciences, ANDRIANOV, V. V., engineer, and SAVITSKIY, Yu. N., engineer

[Abstract] Planing of steel surfaces not harder than R_c 45 with tools made of synthetic diamond (ASV, ASPK-3) is examined from the standpoint of improving the effectiveness by the use of two indenters rather than one. As a typical application the authors consider planing of outside surfaces of cylinders. Three different schemes are compared: 1) the two indenters diametrically on opposite sides of the surface, with different normal forces and forward feeds set for each; 2) both indenters on the same side of the surface, separately one behind the other, with different normal forces but the same forward feed set for each; 3) both indenters on the same side of the surface held securely in a common spring-mounted fixture by set screws. Four main surface quality indicators are evaluted for each scheme on the basis of regression analysis of statistical data on planing of 30KhGSN2A steel with use of lubricant-coolant fluid, these indicators being: roughness (μm), microhardness (MPa), degree of surface hardening (%), and residual stress level (MPa) in a surface layer of a thickness not exceeding 10 μm. The results reveal the advantages of planing with two indenters, they also indicate how the best scheme can be selected and the process parameters (force, feed) in each scheme can be optimized depending on the specific application and on the relative criticality of the various surface quality indicators. The same principle is applicable to surface planing of parts made of other steels, alloys, or with plating. Figures 3, table 1, references 3 Russian.
[43-2415]

UDC 621.891

UTILIZATION OF SELECTIVE MASS TRANSFER FOR INCREASING PERFORMANCE CAPABILITY OF HINGES SUBJECT TO HEAVY LOADS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 48-50

GROMAKOVSKIY, D. G., candidate of technical sciences

[Abstract] A study of selective mass transfer in friction-couples under heavy dynamic loads, specifically of hinges used in aircraft under pressures of 10-100 MPa, has revealed the major factors stimulating this phenomenon. They are regular changes in hardness, density, and stressed state of the surface-layer material during deformation. An important role is played by the structural effect of plastic deformation on polycrystalline materials. Experimental data were obtained on hinges with regular surface relief and hexagonal groove arrays, the pair of materials in friction being BrAZhN 10-4-4 aluminum-iron-nickel bronze and steel. The lubricant was TsIATIM-201 without additives and with up to 5% fluorocarbon added. The results indicate that the wear resistance of plating films can be increased by 30-35%. They also indicate that the plating ingredient should be preferably introduced in the form of metal salts rather than powder, this preference becoming more significant as more fluorocarbon is added to the lubricant. Surface oxidation, which prevents selective mass transfer, is inhibited by an active fluorocarbon facilitating the chemomechanical interaction of friction surfaces and plating ingredient so that the mass transfer becomes more stable and the bond of plating film to substrate metal becomes stronger. Pretreatment of a friction surface with special solvent prior to assembly will limit interaction of that surface and the fluorocarbon. Figures 5, references 9 Russian.
[43-2415]

UDC 621.757-181.2

NOVEL METHOD OF ASSEMBLING LARGE MULTICOMPONENT MACHINE SETS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 52-55

ZHABIN, A. I., candidate of technical sciences, and BROVMAN, M. Ya., candidate of technical sciences

[Abstract] A method of assembling multicomponent machine sets has been developed at the Scientific Research and Design Technological Institute of Machine Construction in Kramatorsk which is based on minimization of power loss in transmission (USSR Patent disclosure No 823,059). Its principle is explained and demonstrated on assembly of a test stand for inspection of mill rollers. The stand constitutes a set of three separately mounted machines: a test cage driven by an electric motor through a speed reducer,

a clutch coupling the motor to the speed reducer and a clutch with a brake coupling the speed reducer to the test cage. Two rollers are simultaneously inserted into the test cage at one end and each is coupled to a brake at its other end. The electric motor is mounted on a fixed base. The speed reducer and the test cage are each mounted on a horizontal plate supported and movable vertically up or down by hydraulic jacks or jack screws resting on another horizontal plate, this lower plate being movable horizontally in two orthogonal directions. The assembly process begins with fixing the motor base and continues with alignment of the shafts. The problem of power loss minimization is formulated as an optimization problem for a criterion functional of four variables: two axial misalignments, vertical and horizontal, and two skew angles. This problem is solved on the basis of 3-level 4-factorial experiments by the probability method of establishing the position which corresponds to minimum power loss, along with the range of equiprobable detection of systematic positioning errors. Guidelines for the application of claw clutches and sprocket clutches in such a test stand have been established on the basis of actual measurements and regression analysis of statistical data. Figures 2, references 5 Russian.
[43-2415]

UDC 621.992

NOVEL TECHNOLOGICAL SOLUTIONS TO TREATMENT OF THREADS IN MICROMETRIC MEASURING TOOLS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 55-57

MATVEYEV, V. V., doctor of technical sciences, and MAL'KOV, G. A., candidate of technical sciences

[Abstract] An analysis of errors in mating microthreads of the screw-and-nut type on the basis of a geometrical model describing such a kinematic pair reveals the predictable limits of threading precision and suggests technological ways to improve the threading precision. Several special tools for finish thread cutting (after rough thread cutting) have been invented on this basis. Among them are two taps for cutting precision microthreads in sleeves made of aluminum-iron bronze (BrAZh9-9), brass (LS59-1), or steel not harder than Bhn 200, one of them with guide-cutter bits (USSR Patent disclosure No 753,568) and the other with a guide separately in front duplicating the thread precut by a rough threading tool. Finishing tools for improving the quality of microthreads include a shaver with precise cutting edges and chip collecting grooves (USSR Patent disclosure No 870,025) and a honer with small threaded planks and bilaterally chamfered teeth. A quality control procedure has also been developed which provides for corrective treatment and salvage of rejects. The metal surface of the tool is first decontaminated, then MoS_2 is deposited on it and the tool is passed over a mating part so that this solid lubricant presses on the surface and fills cavities in it. The resulting smooth surfaces of the microthread pair are additionally lubricated with lanolin or GOI-54p fluid. Figure 1, references 4 Russian.
[43-2415]

UDC 621.891

DEPENDENCE OF REALIZABILITY OF SELECTIVE MASS TRANSFER DURING FRICTION OF ALUMINUM BRONZES AGAINST STEEL ON COMPOSITION OF LUBRICATING FLUID

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 46-47

KRAGEL'SKIY, I. V., doctor of technical sciences, KUKSENOVA, L. I., candidate of technical sciences, TOLOKONNIKOV, V. I., engineer, BERDENIKOV, A. I., engineer, and RYBAKOVA, L. M., doctor of technical sciences

[Abstract] Friction of BrAMts9-2 aluminum-manganese bronze against St45 carbon steel with various fire-resistant lubricants (also with spindle oil for comparison) was tested in the laboratory for realizability of selective mass transfer. Tests were performed on a 77MT-1 machine in reciprocating motion, at constant sliding velocity of 0.1 m/s and under constant specific pressure of 10 MPa as well as at constant temperature. Fire-resistant lubricants used were P10-2 water-glycol mixture and P20M1 water-glycerin mixture, with and without additives. The wear was measured by weighing on an ADV-200M analytical balance. Before and after tests each specimen was examined for microhardness and, by x-ray microphotometry, for layerwise phase composition and crystal structure. The results indicate that water-glycerine without additives, unlike water-glycol mixture and spindle oil, is not a sufficiently adequate selective solvent of precipitating secondary components such as the α_2-phase solid solution in the case of bronzes with high aluminum content and that its additives altogether inhibit anodic dissolution. Figures 3, table 1, references 9 Russian.
[43-2415]

UDC 669.35:6:620.178.162.4

DEPENDENCE OF REALIZABILITY OF SELECTIVE MASS TRANSFER DURING FRICTION OF TIN BRONZES AGAINST STEEL IN HYDRAULIC SYSTEM MECHANISMS ON CONCENTRATION OF ALLOYING ELEMENTS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 44-45

RYBAKOVA, L. M., doctor of technical sciences, KUKSENOVA, L. I., candidate of technical sciences, SAMYLKIN, V. M., engineer, BERDENIKOV, A. I., engineer, and KRAGEL'SKIY, I. V., doctor of technical sciences

[Abstract] Friction between various tin bronzes and steel with fire-resistant water-glycol and water-glycerin lubricant (also with spindle oil, for comparison) was studied in the laboratory for realizability of selective mass transfer. Six industrial tin bronzes (BrOF10-1, BrOF6.5-0.15, BrOF 4-0.25, BrOTsS5-5.5, BrOS10-1-, BrOS5-25) and St45 carbon steel were tested in a 77MT-1 machine in reciprocating motion, with average sliding velocity of 0.1 m/s and under specific pressure of 10-30 MPa. Before and after tests

each bronze member was examined for microhardness and microradiographically with a sliding beam of x-rays for layerwise nondestructive phase analysis. The basis and critical role in the friction and wear process was found to be played by two phases: Cu-Sn α-phase solid solution and $Cu_{31}Sn_8$ intermetallic compound, breakup of the former and partial breakup of the latter resulting in formation of Cu_3Sn. While BrOF bronzes contain also phosphorus which only increases their fluidity, BrOS and BrOTsS bronzes contain also lead which inhibits selective mass transfer. The results of this experiment indicate that monophasality and equilibrium of the alloy favor realizability of selective mass transfer during friction. High tin or lead content as well as high combined tin and lead content are detrimental to selective mass transfer. A typical example of this is BrOF10-1 bronze, an alloy in nonequilibrium state, wearing at a rate which monotonically decreases with time to a stable low level in spindle oil but jumps up and down without reaching a stable level in water-glycol or water-glycerin. Figures 4, table 1, references 7: 6 Russian, 1 Western.
[43-2415]

UDC 621.891

ESTIMATION OF WEAR RATE DURING SELECTIVE MASS TRANSFER

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 41-43

POLYAKOV, S. A., engineer

[Abstract] For calculation of the wear rate during selective mass transfer in a tribological system, the Gibbs energy equation is written for each friction zone in generalized form. Transition from the description of local equilibrium to a description of nonequilibrium processes yields an expression for the increase of entropy in terms of chemical potentials, electric potential, and work of changing an elementary surface area. The processes involved here include diffusion of material components, plastic deformation, adsorption, change of internal energy, change of electric charge, and chemical reactions. On the basis of a criterion for evolution of the tribological state, the Onsager equation is written for the rate of each of these six processes. With hydrodynamic effects disregarded, for simplicity, a solution of this system of six thermodynamic equations yields a simple expression for the rate of chemomechanical wear. With available experimental data on any particular system of friction materials and lubricant, this expression can be used for design calculations and performance evaluation. Table 1, references 9: 8 Russian, 1 Western.
[43-2415]

UDC 621.891

ZERO WEAR (SELECTIVE MASS TRANSFER): NEW STEP TOWARD HIGHER WEAR RESISTANCE OF MACHINE PARTS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 83 pp 36-41

GARKUNOV, D. N., doctor of technical sciences

[Abstract] Selective mass transfer with resulting zero wear is a mode of friction where a thin semifluid "sustaining" metal film forms spontaneously in the contact zone, with attendant decrease of the friction coefficient. Most studies of this novel concept have been made on bronze-steel friction couples. The six factors playing a major role here are: 1) increase of the effective contact area and consequent elastic rather than plastic deformation; 2) adsorption of a positively charged surfactant forming a dense film and preventing oxidation of the metal surfaces; 3) full realization of the Rebinder effect causing only the "sustaining" film and not the metal underneath to deform with minimum internal slippage by the diffusion-vacancy mechanism; 4) coating of metal particles in the wear product (copper micelles) by an electrically charged adsorption layer causing them to migrate either into intersurface cavities or from one metal surface to another; 5) polymerization of organic components in the lubricant, after tribodecomposition of the latter, with the "sustaining" film as catalyst; 6) protection against corrosive-mechanical and abrasive hydrogenous wear. The "sustaining" flim has different properties than the metallurgical material, because it is produced differently: as a result of an ionic reaction after parting of bronze has occurred. Utilization of these properties as well as development and application of lubrication media (glycerin, glycerin-alcohol mixtures, various oils), with determination of optimum thicknesses of the "sustaining" film in each case, are the object of on-going research. It has already been found feasible to achieve zero wear through selective mass transfer also in other metal friction couples such as brass-steel and steel-steel. Figures 6, table 1, references 7 Russian.
[43-2415]

UDC 620.178.5

PROCEDURE FOR DETERMINATION OF DAMPING CAPABILITY OF TURBOMACHINE BLADES SUBJECTED TO HEAT AND CENTRIFUGAL FORCES

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 83
(manuscript received 10 Nov 82) pp 54-57

ADAMENKO, A. Ya., TOKAR', I. G., and MATVEYEV, V. V., Institute of Problems in Strength, UkSSR Academy of Sciences, Kiev

[Abstract] A procedure is being developed at the Institute of Problems in Strength for determining the capability of turbine blades to damp vibrations when subject to centrifugal forces and high temperature. The testing machine designed for this purpose consists of a disk which carries prototype blades or beam models of blades, on a horizontal shaft mounted in cantilever fashion on two roller bearings, inside an enclosure which serves as furnace. The bearings rest on shock absorbers, water cooling and oil lubrication are provided where necessary. Vibrations are excited by means of a VED-400A electrodynamic vibrator at the free end of the shaft extension beyond the furnace chamber and the outer frame, alignment of the shaking table on which the vibrator rests being achieved by means of a platform movable forward or backward, laterally, and up or down. The disk with baldes is heated by a nichrome coil wound on ceramic tubing and lining the walls of the furnace chamber so as to make blade temperatures up to 700°C attainable. Adequate sheathing and thermal insulation are provided where necessary. Measuring instruments include thermocouples for determining the temperature distribution and strain gauges for determining the blade deflections, at disk speeds ranging from 0 to 9000 rpm. The equipment was used for testing blades made of 1Kh13 steel at 0, 7200, 8300, and 9000 rpm. The results indicate that the vibration decrement or damping effect at maximum amplitude of flexural stress decreases with increasing static tensile stress caused by centrifugal forces as well as with rising temperature, being at the maximum temperature and static stress level only about one third of what it is at 20°C and zero static stress (standstill). Figures 3, references 9 Russian.
[47-2415]

UDC 539.434:539.621

ESTIMATING THERMAL FATIGUE STRENGTH OF PROTOTYPE BLADES IN GAS TURBINE ENGINE

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 83 (manuscript received 16 Dec 82) pp 15-17

KOLOTNIKOV, M. Ye. and STRILETS, S. Yu., Kuybyshev

[Abstract] An experimental study was made for the purpose of gathering evidence on the fatigue strength of gas turbine blades under cyclic thermal loads with cooling. Blades of prototype sizes made of ZhS6F heat-resistant alloy were heated over the 523-1373 K temperature range in sawtooth cycles and cooled at rate reaching 25°C/s at the hottest blade section. The test data on stress and strain at rupture have been correlated with calculations of deformation according to the theory of beams, with the boundary conditions established thermometrically on a special blade specimen and the corresponding equations then solved numerically on a YeS-1033 Unified System computer. The results yield the necessary corrections for estimating the thermal fatigue strength according to the general relation $\Delta\varepsilon N^m = C$ or $\Delta\varepsilon_{elast+plast} N^k = C$ (Coffin equation). They indicate a dependence not only on the temperature swing but also on the peak temperature, the magnitude of alternating stresses being more critical than that of alternating strains. Figure 1, references 2 Russian.
[47-2415]

UDC 621.431.74.068.9:621.436

PROBLEMS OF FULL HEAT RECYCLING IN DIESEL POWER PLANTS ON SHIPS

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 83 pp 21-26

YELISTRATOV, F. M.

[Abstract] An important way to improve the fuel economy in diesel power plants is to minimize the heat losses by heat recycling. Full recycling is a problem, especially on ships running with low-speed diesel engines. The design of a heat recycling system is based on the demand for electric energy and for thermal energy during travel, the demand for each being a linear function of the main engine power, as well as on matching necessary and available recycling power. A typical recycling system includes an auxiliary boiler. The three major trends in construction of heat recycling systems are: 1) utilizing the heat of cooling water or of supercharging air, or some power of the main engine, which requires a more intricate layout and additional equipment; 2) special design of existing equipment for maximum energy efficiency; 3) use of working substances with low boiling point such as freons or other refrigerants. These trends have been analyzed

and evaluated from data on heat recycling systems on Soviet tankers and freight carriers as well as Japanese, Norwegian and U.S. ships. Figures 7, table 1, references 25: 13 Russian, 12 Western.
[44-2415]

UDC (621.431.74:621.438).001.63

DESIGN OPTIMIZATION OF AUXILIARY GAS-TURBINE ENGINES FOR SHIPS

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 83 pp 19-21

KURZON, A. G., RIVLIN, E. P. and SEDEL'NIKOV, G. D.

[Abstract] A mathematical model has been constructed for computer-aided design optimization of auxiliary marine gas-turbine engines. It takes into account the effect of the heat recycling loop on engine performance characteristics and allows for varying up to 20 input quantities are included in terms of gas-dynamic thermodynamic, hydrodynamic relations as well as mechanical characteristics of structural materials and cost. The main criterion functional was the cost of generated electric energy, with efficiency and total mass of the plant (turbine + compressor + combustion chamber + foundation plate) as additional optimality criteria. Formulas are given for determining the optimum combination of initial gas temperature and compression ratio. Typical calculations were done for a 1250 kW turbine engine with blades made of EP539VD steel, blades made of this material requiring less air for cooling than blades made of EI765 or EI826 steel.
[44-2415]

UDC 621.313.321

DYNAMICS OF HEATING OF STATOR CORE AND COILS IN TURBOGENERATOR

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 5, May 83 (manuscript received 4 Jan 83) pp 17-21

SCHASTLIVYY, G. G., FEDORENKO, G. M. and KRAMARSKIY, V. A., Kiev

[Abstract] The dynamics of temperature rises and drops in the stator core and coils of a turbogenerator with gas cooling during intermittent-duty operation or load cycling are analyzed on the basis of three-dimensional differential equations of heat conduction with appropriate initial and boundary conditions. The iron core is assumed to be symmetric so that only one sector half a tooth pitch wide needs to be considered. Each axial segment of the core stack between circumferential ducts is assumed to heat or cool independently of all others and can be treated as a homogeneous anisotropic body, its thermophysical properties averaged and assumed not to depend on the temperature. A coil is regarded as a hollow conductor with

equivalent copper cross section and with a ventilation duct of equivalent perimeter. Boundary conditions and constraints are described by sufficiently smooth functions. The equations of heat conduction for a sector of a core segment, for two coil sections (upper and lower) associated with it, and for the coolant are formulated in cyclindrical coordinates. After replacement of the differential equations with approximating difference equations, the boundary-value problem for the resulting system of algebraic equations is solved by the iterative method of successive displacements. The algorithm of the solution has been programmed in the FORTRAN-4. Calculations and numerical estimates have been made for a TGV 200 MW turbogenerator operating in the Lutsk GRES. Four modes of operation were considered: 1) instantaneous dumping of full load from 200 MW to 0; 2) instantaneous dumping of load from 200 MW to light run; 3) gradual dumping of load from 200 MW to light run at rate of 20 MW/min; 4) gradual dumping of load from 200 MW to light run at rate of 40 MW/min. As reference for reliability, also temperatures under nominal operating conditions were calculated by this method, and measured. With the error of measurement not exceeding 5%, the maximum difference calculated and measured temperatures was 3 K in the tooth zone and 5 K in the yoke zone of the stator. Figure 1, references 5 Russian. [56-2415]

UDC 531.381

DETERMINING ORIENTATION OF SOLID OBJECT

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 3, Mar 83 (manuscript received 10 Mar 81) pp 24-32

LARIN, V. B. and NAUMENKO, K. I., Kiev

[Abstract] The orientation of a solid object in a stationary system of coordinates, defined by the coordinates transformation matrix in terms of four Rodrigues-Hamilton parameters, can be determined more accurately with the aid of additional data on the direction of some vector (whose orientation in this stationary system is known) in a moving system of coordinates. The problem is solved by integrating the kinematic equations and estimating the Rodrigues-Hamilton parameters at discrete instants of time from readings of that vector's projections on the axes of the object. The maximum estimate of the Rodrigues-Hamilton quaternion is obtained as the one which minimizes a certain binomial functional with positive coefficients under the constraint that the norm of this estimate be equal to unity. An algorithm is constructed for numerical integration of the kinematic equations in the Rodrigues-Hamilton parameters. Typical results are shown pertaining to an object which rotates at a constant angular velocity about its x-axis. The procedure involves multiplication of elementary quaternions and processing the readings, with errors, of the vector of the object's angular velocity.
Table 1, references 5: 4 Russian, 1 Western.
[54-2415]

UDC 531.381

EQUATIONS IN RODRIGUES-HAMILTON PARAMETERS FOR HEAVY SOLID BODY ROTATING ABOUT FIXED POINT

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 27 Jan 83) pp 16-25

KOSHLYAKOV, V. N., Kiev

[Abstract] Rotation of a heavy solid body about a fixed point O not located at its center of mass is analyzed in two systems of coordinates:

$O\xi\eta\zeta$ inertial stationary and Oxyz moving with the body. The conventional system of three Euler equations (dynamics) and three Poisson equations (kinematics) are replaced with their Rodrigues-Hamilton analog, with an additional equation obtained by twice differentiating the interrelation between the four Rodrigues-Hamilton parameters. The general result is applied to rotation of a heavy solid body with arbitrary mass distribution and a single stationary point about the vertical axis passing through its center of mass. As a practical example is considered a modification of the Lagrange spinning top, namely one with $A = B = 1/2C$ (moments of inertia with respect to axes x,y,z respectively) and $\alpha>0$ (center of gravity above pivot point). Advantages of this method of analysis are the possibility of rigorous linearization and, in the case of small nutation angles, the absence of singularities. Its disadvantage is the higher order of equations, the six first-order differential Euler-Poisson equations being replaced by four second-order differential Rodrigues-Hamilton equations equivalent to eight first-order differential equations. References 12 Russian.
[55-2415]

UDC 531.38

EQUATIONS OF SMALL OSCILLATIONS FOR INERTIAL NAVIGATION SYSTEM TAKING INTO ACCOUNT EARTH'S ELLIPSOIDALITY

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 17 Feb 82) pp 51-56

ZHBANOV, Yu. K., Moscow

[Abstract] An inertial navigation system is considered for a platform in a suspension to be horizontally stabilized. The corresponding Euler-Poisson equations of small-amplitude oscillatory motion in the approximation of a spherical earth are refined for ellipsoidality of the earth by inclusion of the eccentricity as correction factor. The equations are formulated for navigation with not only the instrumental trihedron but also an auxiliary instrumental-geographical one and a dead-reckoning one. The equations are explicated and put in matrix form, expressing the dependence of horizontal stabilization error on errors in the dead-reckoning channel due to ellipsoidality of the earth. Figure 1, references 7 Russian.
[55-2415]

UDC 531.383

MECHANICS OF 'RIGID' GYROSCOPIC SYSTEMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 10 Feb 83) pp 57-65

KLIMOV, D. M., Moscow

[Abstract] A navigation problem, namely vertical stabilization of a ship with a system of gyroscopes, is analyzed on the basis of the simple example of a ship moving along the equator and its position defined by the meridian angle. The equation of motion for a "rigid" pendulum is formulated so as to describe small oscillations of the latter at a Schuler frequency. Following a review of previous studies on the mechanics of such systems and of concepts already developed, notably by A. Yu. Ishlinskiy (1956) and V. N. Koshlyakov (1961-72), the conditions for "rigidity" are established first in general form and then for the specific case under consideration. Next are analyzed the motion of a pendulum with the initial condition for "rigidity" not exactly satisfied and the motion of a "rigid" system relative to a system of coordinates with the same origin but one axis passing through the center of the earth. Figures 6, references 25: 23 Russian, 2 Western.
[55-2415]

UDC 531.383

CONTROL OF QUADRIAXIAL CARDAN SUSPENSION

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 14 Feb 83) pp 66-70

NOVOZHILOV, I. V., Moscow

[Abstract] A quadriaxial Cardan suspension is to be servomechanically controlled so as to stabilize a definite orientation of the platform during arbitrary motion of the frame. The problem is solved with the use of five orthogonal systems of coordinates tied one to the platform, one to each of the three gimbals, and one to the frame respectively. The suspension is assumed to be structurally perfectly rigid and to be part of a gyroscopic indicator-stabilization system. The corresponding dynamic equations are written as equations for angular momenta and several variants of control, for the various rotations, are constructed. One such variant, a more intricate one, is course-vertical control. Dynamic control of the suspension in a stationary frame, to ensure any arbitrarily prescribed angular evolutions of the platform, is also considered and the procedure for constructing such a control is outlined. Figures 2, references 10 Russian.
[55-2415]

UDC 531.383

METHOD OF DERIVING EQUATIONS OF MOTION FOR DYNAMICALLY ADJUSTABLE GYROSCOPE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, Mar 83 (manuscript received 6 Jan 81) pp 12-18

SHATALOV, M. Yu., Moscow

[Abstract] The equations of motion for a dynamically adjustable gyroscope are derived in terms of the Lagrange function, of generalized coordinates and velocities and of time, this function assumed to be analytic. The derivation is based on applying an Euler operator to the corresponding Lagrange equation of the second kind and analyzing the Lagrange function as the difference between kinetic energy and potential energy. Linear differential equations of motion are derived in this way, first for a gyroscope with single wheel and then for one with n wheels in tandem. The method is also applicable to derivation of linearized nonlinear equations or their higher-order approximations. The author thanks V. F. Zhuravlev and D. M. Klimov for formulation of the problem and discussion of the results. Figures 6, references 3: 2 Russian, 1 Western.
[54-2415]

UDC 531.383

PROBABILISTIC CHARACTERISTICS OF PERTURBATION TORQUES IN GYROSCOPES WITH ELECTROSTATIC SUSPENSION

MOscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, Mar 83 (manuscript received 1 Mar 82) pp 4-11

KORETSKIY, A. V. and MARTYNENKO, Yu. G., Moscow

[Abstract] Determining the perturbation torque on the wheel of a gyroscope with electrostatic suspension is treated as a problem in the theory of probability. The wheel is assumed to spherical in form with a randomly nonuniform surface. Such a surface is described by an equation in Fourier series of spherical functions. The electrostatic potential in the gap between the wheel surface and the inside surface of the housing in which the wheel has been suspended is also expressed in the form of a power series in a small parameter with harmonic functions expandable into associated Legendre polynomials of the first kind as coefficients, this electrostatic potential representing the solution to the Laplace equation for the electric field set up by an array of electrodes. The force distribution and then the moment with respect to the center of mass are calculated on this basis statistically, in terms of mathematical expectation and dispersion. The corresponding correlation coefficients are calculated after the correlation function, which depends only on the distance between points on the wheel

surface, has been expanded in a Fourier-Legendre series with only cosine terms of the Legendre polynomials. The dependence of the dispersion of the perturbation torque on the parameters of the electrostatic suspension is evaluated and the performance of the latter is determined in a typical specific example with given numerical values of gyroscope wheel and electrode system parameters: mass of wheel 0.02 kg, voltage between electrodes 3 kV, clearance between wheel and electrodes d = 0.01R (R- radius of wheel). Table 1, references 6 Russian.
[54-2415]

UDC 629.125.8:533.693

AUTOMATIC CONTROL OF SHIP'S ASCENT ONTO HYDROFOILS

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 83 pp 27-28

METLIN, V. A. and SHLEYENKOV, I. F.

[Abstract] The object of controlling a ship's motion on hydrofoils is establishing the optimum trajectory, one that will minimize the travel time and the energy consumption. Both stabilizing hydrostatic effects and destabilizing hydrodynamic effects must be taken into account in automatic control of the ship's ascent onto hydrofoils. Such an automatic control system designed to minimize the transient period reduces the problem to that of maximizing the Krotov function $R(H,V) = (G - F)/(P- X)V + \int_{V_0}^{V} \frac{\partial(1/P- X))}{\partial H} dV$ (G- weight of ship, P- programmable engine thrust, X- drag force, F- lift force, V- velocity of ship, H- altitude of center of mass), with $F = Q + Y > G$ (Q- hydrostatic component and Y- hydrodynamic component of lift). The system contains draft and tilt transducers, amplifiers, a set of regulators with feedback, a null reset and servomotor, and two relays, one driven by a switch consisting of a draft AND gate and a tilt AND gate, each preceded by diodes, as well as an OR gate behind both. With the aid of this automatic control system, it is possible to program changes in the ascent height as function of the ship velocity. Figures 3, references 1 Russian.
[44-2415]

UDC 533.6.011.55

ANALYTICAL DESCRIPTION OF HYPERSONIC GAS JET DISCHARGED INTO MOTIONLESS MEDIUM OR INTO SUPERSONIC COMPANION STREAM

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 16 Apr 82) pp 183-186

GILINSKIY, M. M. and ZAK, L. I., Moscow

[Abstract] An integro-differential equation has been obtained in an earlier study (IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA No 5, 1969) as an approximate analytical description of discharge of a supersonic jet from a diverging nozzle into a flooded space or into a supersonic companion stream, with the power-law profile characterized by an exponent $\nu = 0,1,2$ for flow with respectively plane, cylindrical, or spherical waves. The flow of an ideal thermodynamically perfect gas through a slightly diverging nozzle was assumed not by the method of plane sections but by reduction to a second-order ordinary differential equation for the propagation of an internal "barrel" density jump. This differential equation is transformed into an integral one where the density jump appears both explicitly in the polynomial part and also under a double integral. Evaluation of the latter by iterations yields the solution in the form of an algebraic equation for $\nu = 1$ (conical nozzle). It remains to determine the point at which the first "barrel" ends. An interesting special case is that of an underexpanding nozzle. References 4: 2 Russian, 2 Western.
[52-2415]

UDC 533.6.011

AERODYNAMIC AND THERMAL CHARACTERISTICS OF THREE-DIMENSIONAL STELLATE BODIES IN RAREFIED GAS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 30 Mar 82) pp 181-183

BUNIMOVICH, A. I. and KUZ'MENKO, V. I., Moscow

[Abstract] In search for the aerodynamically optimum shape of bodies to be launched into space, studies are made of stellate bodies flying at hypersonic

velocities through rarefied air at various altitudes. A specific shape under consideration here is that of a body consisting of a regular n-arm star in front and a round back with a smooth transition between them. The aerodynamic drag coefficient and the heat transfer coefficient at the front have been calculated and measured as functions of the characteristic relative body width r/L (ratio of radius at midspan to total length) and of the altitude H or air density. The calculations were based on the "localizability" hypothesis, with the local dimensionless pressure and heat parameters expanded into finite series

$$G = \sum_{i=1}^{R} D_{ij}\cos^{i}\theta$$ (θ- angle of attack; coefficients

$D_{ij} = D_{ij}(N_{R,o}, c_p/c_v, T_w, \sigma)$, $N_{R,o}$- Reynolds number at stagnation point, T_w- wall temperature, σ- rarefaction ratio). Calculations for V = 7 km/s, $= c_p/c_v = 1.4$, and $T_w/T_o = 0.01$ reveal that such a shape is optimum aerodynamically within a narrow range of r/L and thermally over a wide range of r/L at H = 70 km, is neither aerodynamically or thermally optimum at H = 90 km (where viscous friction becomes strong relative to pressure), is inferior to axisymmetric shapes (solids of revolution) at H = 110 km, and that at H = 130 km (where hypersonic flow at $N_M \simeq 20$ approaches free-molecular flow) there is almost no difference in drag and only some differences in heating between all shapes. These results have been confirmed by measurements made on ballistic missiles with graphite heads subject to ablation. The optimum shape in very rare air is an axisymmetric shape, partly optimum being a stellate shape with few arms (n = 2). Figures 2, references 8: 7 Russian, 1 Western.
[52-2415]

UDC 532.5

INTERNAL BALLISTICS OF HYDRAULIC GUN

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 5 Jan 82) pp 168-170

ATANOV, G. A., SEMKO, A. N. and UKRAINSKIY, Yu. D., Donetsk

[Abstract] A theoretical-experimental study of a precussion-type hydraulic gun was made, for the purpose of determining its internal ballistics in the case of jet splitting upon discharge. Water was discharged through a nozzle upon impact by a piston generating a shock wave, the piston having been set in motion by release of compressed air. The velocity of the piston at the instant of impact was measured with an electromagnetic transducer, the pressure inside the barrel was measured with a "wire breaker" transducer, and the discharge velocity of water was measured with a conduction-type anemometer in a magnetic field (0.15 T) in the nozzle throat section (the interelectrode space having been prefilled with water prior to jet discharge so as to avoid a jump of induced emf). Calculations were based on the quasi-one-dimensional approximation, according to S. K. Godunov, with the

equations written in divergence form. A moving constant-mesh grid regular with respect to the space coordinate and with time steps satisfying the Courant stability condition was used for computation so as to accomodate the boundary conditions at the accelerating piston as well as the discontinuous initial conditions. Both experiment and calculation reveal the nonuniform nonsteady character of discharge. The results indicate that the quasi-one-dimensional approximation is valid, as long as the cross-sectional area does not change suddenly. Figures 3, references 3 Russian.
[52-2415]

UDC 533.695.5

MATHEMATICAL MODELING OF TRANSIENT SEPARATION FLOW AROUND CIRCULAR CYLINDER

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 4, Apr 83 (manuscript received 23 Nov 82) pp 138-147

BELOTSERKOVSKIY, S. M., KOTOVSKIY, V. N., NISHT, M. I. and FEDOROV, R. M.,
Moscow

[Abstract] A numerical method is proposed for complete solution of the problem of transient separation flow of a viscous fluid around a cylinder. It is based on existing models of a boundary layer and on assuming an ideal medium, and it requires no additional empirical data. The potential flow outside the boundary layer is mathematically modeled by a system of N+1 dimensionless algebraic equations in series form describing the circulation of discrete vortices. At time zero N of these equations represent the condition of impermeability of the cylinder surface and one represents the condition of zero tangential velocity at the stagnation point. For subsequent instants of time the N equations are modified to represent the condition of impermeability at successive points on the surface and the one equation is modified to represent the Thomson theorem of constant circulation around a contour enclosing both the body and its trail. The boundary layer is simulated not only on the front side from the stagnation point to the separation point on each side but also on the rear side with backstreams within the zone between the two separation points there. Viscous flow in the boundary layer is described by the conventional system of differential equations of a nonsteady boundary layer, with both kinematic and eddy viscosity as parameters. Two models of eddy viscosity according to Van Driest and Klebanov close this system of equations: the Prandtl "mixing path" model with a laminar sublayer, a longitudinal pressure gradient and damping by the wall for the inner subregion and the "constant eddy viscosity" model with intermittency for the outer subregion. The two coefficients characterizing transient aerodynamic forces at points on the cylinder surface, drag and lift respectively, are determined from the Cauchy-Lagrange pressure integral. This simulation of flow in the boundary layer was tested by the method of finite differences and approved on the basis of comparison with other exact and approximate solutions for circular as well as elliptical cylinders. Given illustration are results of calculations of transient separation flow around a circular cylinder after the latter

has been suddenly set in motion. Both an only semiempirically describable turbulent boundary layer and an analytically describable laminar boundary layer were modeled in this manner. The authors thank G. I. Petrov for helpful comments and discussions. Figures 5, references 18: 13 Russian, 5 Western.
[52-2415]

UDC 533.6.011.8

INTERACTION OF JET DISCHARGED FROM CONTAINER AND OPPOSING SUPERSONIC STREAM OF RAREFIED GAS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 2 Dec 81) pp 132-137

LARINA, I. N., Moscow

[Abstract] The problem is interaction of a supersonic stream of rarefied mono-atomic gas and an opposing jet discharged through a nozzle (radius r) from a spherical container (radius R) in that stream. The flow function, describing the state of the gas, is assumed to satisfy either the Crooke relaxation equation or S-model kinetics. The temperature dependence of dynamic viscosity is assumed to correspond to the Lennard-Jones model of particle-particle interaction. The dimensionless equations of interaction in integral representation, four nonlinear ones for Crooke kinetics or six nonlinear ones for S-model kinetics, are solved by numerical iteration for boundary conditions of unperturbed flow at infinity and diffuse reflection by the outside container surface. The distribution function of discharged gas particles at the nozzle orifice is given as $f(x_j,\xi_j)_o =$

$n_o(\pi T_o)^{-3/2}e^{-(\xi - S_o)^2/T_o}$ in x_j,ξ_j coordinates (n- gas density, T- gas

temperature, S- stream velocity). Velocity vector fields, temperature and density fields have been calculated by this method for streams with $S = \{4,7\}$, Reynolds number $Re \approx 30$, and Knudsen number $Kn = \lambda_\infty/2R = \{10,1,0.4\}$ (λ_∞- length of mean-free-path for molecules in oncoming stream), with gas density $n_o = \{10,15,30\}$ and gas temperature $T_o = 4.5$ at the nozzle orifice. Also the dependence of the hydraulic drag coefficient on the gas density in the jet has been determined in the process. Figures 2, references 6: 4 Russian, 2 Western.
[52-2415]

UDC 533.6.011.55

METHOD OF CALCULATING STRONG VISCOUS INTERACTION AT DELTA WING

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 6 Apr 82) pp 119-124

DUDIN, G. I. and LYZHIN, D. O., Moscow

[Abstract] A method of iteration is proposed for calculating the parameters of a three-dimensional boundary layer at the surface of a thin delta wing in a hypersonic stream of viscous gas. The model is a semi-infinite equilateral triangular plate oriented at a zero angle of attack, in a Cartesian system of coordinates with the origin at the vertex point and the x-axis as axis of symmetry. The equations of flow are reduced to a system of equations in two independent variables, through use of self-adjoint variables, with singularities of the flow function in the vicinity of the leading edges accounted for by means of similarity variables. The temperature dependence of dynamic viscosity is assumed to be linear and the Prandtl number appears as a characteristic parameter. The equations are solved by the "shearing wedge" method, applicable where $M_\infty s^{1/4}/Re^{1/4} \gg 1$ ($s = \cot \alpha$ aspect ratio, M_∞- Mach number at infinity before wing, Re- Reynolds number in unperturbed stream) and the pressure in the Dorodnitsyn formulation is $p^o = 1/2(1 + \gamma)(\partial\delta^o/\partial x)^2$ ($\gamma = c_p/c_v$, δ^o- displacement thickness of boundary layer). At the beginning of each iteration is given the transverse pressure profile (z- or span coordinate) so that the pressure at both edges equals the pressure of the stream at corresponding points. Iteration proceeds according to the relaxation method, with directions varied to conform with changes in the propagation of perturbations through the backstream regions. The fields of flow functions are calculated which then yield the displacement thickness of the boundary layer. Iteration continues until the calculated pressure profile coincides with the initially stipulated one. This method, much faster than known methods, was tested on finite wings with sweepback angles ranging from 50° for flow with runoff toward the plane of symmetry to 2° for flow with backstreams. Figures 5, references 7 Russian. [52-2415]

UDC 533.6.011.5

MIXED BOUNDARY-VALUE PROBLEMS PERTAINING TO PROFILE OF SUPERSONIC NOZZLES AND CHANNELS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 16 Feb 82) pp 112-118

BOYNOVSKIY, A. S. and KIREYEV, V. I., Moscow

[Abstract] Two mixed boundary-value problems are formulated pertaining to two-dimensional supersonic separation flow through channels, problems of

profile design, with discontinuities stipulated in the form of either shock waves or contact boundaries. A piecewise-continuous line G representing the C^+ or C^- characteristic line is given along with the vector-column of a discontinuous gas-dynamic parameter defining a supersonic flow along this line as function of the stream parameter χ or as function of the radius-vector r_G of points on that line, as well as a piecewise-continuous boundary line Q intersecting line G at only one point and confined within the corner between characteristics C^+ and C^-. The given gas-dynamic parameter is the angle between the velocity vector and the longitudinal channel axis $\theta(\chi)$ or $\theta(r_Q)$ in problem "3" and the pressure $p(\chi)$ or $p(r_Q)$ in problem "4" (r_Q-radius-vector of points on line Q). An analytical solution of each problem is possible in special cases such as plane flow with uniform initial G-characteristic. A numerical solution for other cases by the method of grids and characteristics, with subdivision into χ = const layers, has been programmed in FORTRAN-4. The authors thank U. G. Pirumov, M. Ya. Ivanov and A. N. Karyko for helpful comments. Figures 5, references 7 Russian.
[52-2415]

UDC 533.6.011:523

FLOW OF STELLAR WIND PAST X-RADIATION SOURCE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 3 Mar 82) pp 106-111

KRASNOBAYEV, K. V. and SYUNYAYEV, R. A., Moscow

[Abstract] Stellar wind past an x-ray source is treated as two-dimensional steady flow of a fully ionized plasma containing both protons and electrons. The corresponding equations of hydrodynamics and state, in a cylindrical system of coordinates with temperature as third variable, are solved for a supersonic gas stream. An analysis of the solution for dependence on the distance from the radiation source reveals that as this distance decreases, the amplitude of perturbations increases and near the source the stream becomes subsonic. Numerical integration of these equations must, therefore, be performed over a range several times wider than the critical distance at which radiative heating of the plasma raises its heat content to a level comparable to that of its kinetic energy. The authors also consider changes not only in the plasma temperature but also in the wind ionization content and corresponding changes in the plasma cooling rate caused by deexcitation of ions of heavy elements along streamlines. The results indicate existence of a forward shock wave with a cavity containing hot gas behind the front, and acceleration of the stream within the subsonic region. Figures 6, references 8: 6 Russian, 2 Western.
[52-2415]

UDC 532.594

LOGARITHMIC DECREMENT OF OSCILLATIONS OF LOW-VISCOSITY FLUID ROTATING INSIDE CYLINDRICAL VESSEL

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 4, Apr 83 (manuscript received 18 Mar 82) pp 85-92

RADYAKIN, N. K., Kharkov

[Abstract] A low-viscosity weightless fluid occupying an axisymmetric part of a circular cylindrical vessel and rotating together with the latter at a constant angluar velocity in a zero-gravitation field is considered to be subject to small normal oscillations about its equilibrium position. The corresponding equations of motion and boundary conditions are written in a cylindrical system of coordinates rotating with the fluid. The fields of velocity and pressure fluctuations are assumed to vary harmonically, the real part of the complex exponent representing the logarithmic decrement. The latter is calculated, considering that both velocity and pressure fields satisfy the linearized Navier-Stokes equations as well as the condition of incompressibility. Assuming that the viscosity forces are much smaller than the capillary forces and the latter are comparable with the centrifugal forces, the problem is treated as an asymptotic one with respect to viscosity for the linearized Euler equations and as a variational one for surface waves in an ideal fluid. It is solved by the Ritz method with appropriately selected coordinate functions. Numerical results have been obtained on an M-220 computer for modes m = 0, ± 1, ± 2 and various natural frequencies of the fluid in a cylinder with H/R = 2 and with the wetting angle ranging from 45° to 90°, the number of coordinate functions being varied from 4 to 8. Calculations with the aid of Simpson's rule indicate that using six coordinate functions will yield a sufficiently close approximation. The author thanks N. D. Kopachevskiy for assistance and helpful comments. Figures 4, tables 2, references 12 Russian.
[52-2415]

UDC 532.593:532.529

INTERACTION OF AIR SHOCK WAVES AND POROUS SHIELD

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 4, Apr 83 (manuscript received 8 Jan 82) pp 79-84

GEL'FAND, B. Ye., GUBANOV, A. V. and TIMOFEYEV, Ye. I., Moscow

[Abstract] Experimental data are presented on propagation of nonsteady shock waves through porous solid media such as foam and on interaction at the foam-air or air-foam interphase boundary. Tests were performed with two grades of foam polyurethane, low-density (20 kg/m^3) with large cells (2-6 mm) and high-density (35 kg/m^3) with small cells (1 mm). Tests were performed in an air shock tube with 30x45 mm^2 rectangular cross section

consisting of a 0.5 m long high-pressure compartment and a 1.8 m long low-pressure compartment separated by a membrane. Measurements were made with stiff piezoelectric pressure transducers and oscilloscopes. The data have been evaluated on the basis of the Rudinger model, representing a two-phase medium as a pseudogas with equivalent adiabatic exponent and acoustic velocity. The results reveal the dependence of the pressure field, indicating the pattern of wave reflection and refraction with the attendant energy transfer, on the structural characteristics of the porous medium: cell size and acoustic impedance relative to that of a continuous solid medium. Figures 4, references 10: 6 Russian, 4 Western.
[52-2415]

UDC 532.581.011

AERODYNAMICS OF HOVERING

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 24 Dec 81) pp 71-78

ZAYTSEV, A. A. and SHARINA, L. V., Moscow

[Abstract] An analysis of hovering aerodynamics is performed on the basis of a three-dimensional model of nonsteady flow past a pair of flapping wings in motionless air. The house fly, whose flight characteristics and wing parameters are known is taken as a practical example. The kinematic model is supplemented with the theory of a supporting surface, with such a surface and the companion vortex sheet each described in a system of its two Lagrangian coordinates. The resulting system of equations has been solved numerically, with the flow function approximated by means of a bicubic spline in Lagrangian variables at discrete instants of time. The results reveal the effects of kinematic factors on the wing aerodynamics and indicate what the wing parameters must be to ensure an adequate supporting force at a given flapping frequency. Figures 5, references 11: 9 Russian, 2 Western.
[52-2451]

UDC 532.526.4/5

ASYMPTOTIC THEORY OF SEPARATION FLOW

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 18 Mar 82) pp 47-54

SYCHEV, Viktor V., Moscow

[Abstract] Separation flow at a body surface is analyzed by the asymptotic method according to the theory of a turbulent boundary layer. The velocity

field in the region around the separation point is determined for an ideal fluid with free streamlines, assuming that the Reynolds number approaches infinity, with the pressure gradient along the surface and the curvature of a streamline described by known asymptotic expansions. The two-dimensional Reynolds equation of a boundary layer are formulated in a system of Cartesian coordinates with the origin at the separation point and its two axes respectively on and normal to the plane surface. The region of the stream is divided into five sublayers, two converging to and terminating at the separation point and three continuing beyond. Backstreams appear within a thin laminar sublayer behind the separation point. The velocity profiles in these sublayers are calculated from the corresponding systems of equations, those for turbulent sublayers requiring closure with a model of turbulence and use of the Heaviside function at the separation point, and with the solutions appropriately collocated. The turbulence model is based on the Prandtl mixing path hypothesis and a recurrence relation for the coefficients. The authors thanks V. V. Sychev and A. I. Ruban for discussion. Figures 4, references 21: 5 Russian, 16 Western.
[52-2415]

UDC 532.526.2.013.2

EFFECT OF INJECTION INTO BOUNDARY LAYER ON FLOW OF SUPERSONIC STREAM PAST OSCILLATING CONE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 4, Apr 83 (manuscript received 4 Jan 82) pp 43-46

KORNIYENKO, Ye. S. and SHMANENIKOV, V. N., Moscow

[Abstract] Interaction of a stream of ideal gas and a boundary layer is analyzed for a supersonic stream and an acute cone oscillating about its zero-angle-of-attack position. First the equations of a nonviscous gas are solved, assuming a zero thickness of the boundary layer. Then the equations of a boundary layer are solved for the normal component of velocity at the outer edge of the laminar sublayer, whereupon the equations of an ideal gas are solved with the injection velocity at that edge set equal to that normal component. The cone is referred to a Cartesian system of coordinates whose one axis coincides with the cone axis and to a spherical system of corrdinates with the origin at the cone vertex. The equations of motion for a gas through the boundary layer at the surface of a cone oscillating with small amplitude are written in Blasius variables and solved, as are the equations of state, by separation of variables with each sought function expressed in the form of a power series in the Struhal number. The effect of gas injection on the damping of cone oscillations is then evaluated for the case of heating and sublimation of the cone material by a nonsteady thermal flux. The results indicate that a boundary layer decreases the damping when the injection rate is low, but increases it more than in the case of a nonviscous gas when the injection rate becomes sufficiently high. Figures 2, references 3 Russian.
[52-2415]

UDC 532.5.013.4:536.2

EFFECT OF NONHOMOGENEITY ON NONLINEAR STABILIZATION OF ACOUSTIC VIBRATIONS IN HEAT EMITTING MEDIUM WITHIN BOUNDED VOLUME

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 4, Apr 83 (manuscript received 22 Feb 82) pp 3-8

VOROB'YEV, A. P., Moscow

[Abstract] The acoustic stability of a heat emitting gas is analyzed on the basis of the equations of gas dynamics under conditions of thermodynamic equilibrium, with the thermal radiation flux described according to the diffusion theory. The steady-state intensity of heat release and coefficient of radiative heat transmission as well as coefficient of heat transfer through the lateral channel wall and temperature of the latter are assumed to be negligible in comparison with attenuation of thermal radiation, the latter also being assumed to remain uniform. The gas is stationary in the steady state, with heat transfer through the lateral channel wall occurring in accordance with Newton's law and longitudinally by conduction. The conservative problem is considered with a longitudinal density gradient. The corresponding boundary-value problem generates a system of eigenfunctions and eigenvalues, with eigenfunctions corresponding to different eigenvalues being orthogonal. The nonlinear problem, put in operator form, is solved by the method of variation of arbitrary constants with the conservative part expanded into eigenfunctions. A specific numerical example is a gas with small sinusoidal nonhomogeneity and a steady-state temperature peaking at the channel center section. The author thakns K. I. Artamonov for attention, support and creative comments on interaction of unstable acoustic waves in heat emitting medium. References 3 Russian.
[52-2415]

UDC 532.527.011

VORTICAL-POTENTIAL FLOW OF IDEAL FLUID ALONG PLANE WITH DEPRESSION

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 25 Dec 79) pp 161-163

SADOVSKIY, V. S. and SINITSYNA, N. P., Moscow

[Abstract] The problem of flow of an ideal incompressible fluid along a plane is solved exactly for the cast of an unbounded stream passing over a transverse semicylindrical depression along the path. For an analytical formulation of this problem, the flow is assumed to be potential above the plane and the depression but vortical inside the depression. At the separation line there occurs a positive jump of the Bernoulli constant $\Delta B_c = 1/2(V_o^2 - V_i^2)$, its magnitude being obtainable from the condition of continuity and the Bernoulli integral, while the vortical-potential flow

satisfies the Prandtl-Batchelor condition. The boundary-value problem for the corresponding two-dimensional Laplace equation is solved with the aid of conformal mapping and subsequent reduction to two nonlinear integral equations in two unknown functions (streamline separatrix and jump of normal derivative) of one coordinate (longitudinal). The solution becomes more intricate in the case of asymmetric flow. The algorithm has been programmed for a BESM-6 high-speed ocmputer. Numerical results for the $\psi = 0$ streamline and $\Delta B_c = 0, 0.025, 0.1, 0.2, 0.3, 0.4, 0.5$ indicate no "stirring" of the solution. Figures 2, table 1, references 4: 3 Russian, 1 Western.
[53-2415]

UDC 532.525.011.5

SUPERSONIC THREE-DIMENSIONAL JET FLOW IN CHANNEL

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 21 Jul 80) pp 155-159

ANTSUPOV, A. V. and SHUYNOV, A. V., Moscow

[Abstract] An experimental and computational study was made of supersonic three-dimensional flow in a cylindrical channel upon jet discharge from an asymmetrically oriented nozzle. The main objects were the distributions of pressure and lateral force on the channel wall, as functions of the ratio of static pressure in nozzle to static pressure in channel over the 0.5-7.0 range and of the ratio of channel radius to nozzle radius over the 1.5-3.0 range. Experiments were performed inside a continuous-duty pressure chamber. Three conical nozzles were used, with half vertex angles $\alpha = 13, 10, 17°$ respectively, discharging jets at velocities M - 2.17, 2.60, 3.0 correspondingly. The channel length to diameter ratio was varied from 2 to 8. Calculations were performed according to the steady analog of the S. K. Godunov method, for attached flow in such a channel, assuming an ideal (nonviscous and thermally nonconducting) gas. The close agreement with experimental data indicates that this numerical method of analysis can yield an accurate complete flow pattern. The effect of nozzle translation and nozzle rotation was, accordingly, aslo studied. Forward displacement of the nozzle has been found to sharply increase the pressure peaks and almost linearly increase the lateral force. Rotation of the nozzle has been found not to increase the pressure peaks appreciably and to cause oscillatory change in the lateral force. Figures 5, references 11: 9 Russian, 2 Western.
[53-2415]

UDC 532.51.001

SEPARATION FLOW OF TRANSSONIC WATER STREAM PAST CIRCULAR CONE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 17 Mar 81) pp 152-154

AL'YEV, G. A., Leningrad

[Abstract] Axisymmetric flow of water at constant velocity V_∞ past a circular cone of finite length is analyzed in the range of water pressures not exceeding 2940 MPa, where its static and dynamic adiabats remain almost identical and can be described by the Tate equation. The corresponding system of equations of continuity and motion, in matrix form, is closed by the steady-state Bernoulli equation. Solution of this system by numerical integration according to a two-dimensional straight-through difference scheme has been programmed in ALGOL-60 for a BESM-6 high-speed computer. The frontal drag coefficient as a function of the Mach number has been calculated with an NxM = 60x40 grid for cones with half vertex angles α = 10, 1913, 26.6° respectively. The results differ appreciably from those based on the linear theory as the vertex angle becomes wider. At a cone with α = 10° the drag coefficient increases only as the Mach number M_∞ increases from 1 to 1.6, whereupon it decreases because of an attached density jump at $M_\infty \geq 1.6$, while at cones with o = 19.3, 26.6° no density jump occurs within the $1.5 \leq M_\infty \leq 3$ range. The distribution of the pressure coefficient along the cone surface has been calculated with a 30x20 grid. At $M_\infty = 1$ this coefficient decreases with increasing distance from the vertex, but at $M_\infty > 1$ its distribution tends to become uniform. All flow parameters become uniform over the cone surface upon disappearance of a transsonic flow region behind the density jump. The author thanks M. Ya. Ivanov and A. N. Krayko for the program of calculating the flow of an ideal gas past a solid of revolution, serving as basis for the program of calculations in this study, also L. I. Slepyan for helpful discussion of the results. Figures 3, references 6 Russian.
[53-2415]

UDC 532.5.012.2

IMMERSION OF DISK IN COMPRESSIBLE FLUID AT ANGLE TO FREE SURFACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 2 Mar 81) pp 142-144

YEROSHIN, V. A., Moscow

[Abstract] Fast immersion of a disk in a compressible fluid is considered in the oblique mode rather than with the disk falling flatly so that an "air cushion" forms or falling vertically on edge. The dependence of the maximum

impact drag coefficient and of the length of the transient period of impact load buildup on the Mach number of the disk prior to impact is established from exprimental data. The conventional expression for the maximum impact drag coefficient in the case of immersion in an incompressible fluid such as water is modified so as to take into account compressibility of the fluid and remove the singularity $C_x^{max} \to \infty$ as the difference between angle of disk trajectory θ and angle of attack α approaches 90°. The semiempirical expression for the maximum impact drag coefficient is $C_x^{max} = 0.8\cos\alpha[1 + \sin\theta/\cos(\theta - \alpha - kN_M)]$ with $k = k(N_M,\theta)$ generally, coefficient k being approximately constant only in the case of flat fall at acoustic velocity ($k = 0.4$) and in the case of symmetric vertical fall ($k = 0.35$). The corresponding semiempirical expression for the transient time is $t_{max} = 1.24/\tan(\theta - \alpha - \lambda N_M)$ with $\lambda = 0.35/(1 + 3N_M)$. Figures 2, references 5 Russian.
[53-2415]

UDC 533.6.011.72:538.4

MAGNETOHYDRODYNAMIC FLOW PAST NONCONDUCTING WEDGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 9 Feb 82) pp 102-112

PUSHKAR', Ye. A., Moscow

[Abstract] The problem of MHD flow past a nonconducting wedge facing the stream at an arbitrary angle of attack is solved by a numerical method for the case of plane polarization with the magnetic field not parallel to the velocity vector. Only a "weak" solution, corresponding to slow shock waves, is sought with three dimensionless parameters: Mach number M, Alfven number N, angle ψ between the velocity vector and the magnetic field vector. Four boundary conditions are established, zero normal velocity component at each wedge face and equal magnetic field intensity components (tangential and normal) at both wedge faces, this number of conditions being equal to the number of unknowns and the problem thus being well-conditioned. The solution is plotted in the θ_1,θ_2 plane of wedge angles (angles of the two wedge faces with the velocity vector as x,y coordinates respectively). Calculations have been made for an Alfven number $N < 1$ ($N = 0.6$) and a Mach number $M > 1$ ($M = 2$) with $\psi = 90°$, 72°32' ($\cos^{-1} N/M$ strong crisis), 65°, 50°, 30° ($\cos^{-1} 1/M$ weak crisis) and for an Alfven number $N > 1$ ($N = 5$) and a Mach number $M > 1$ ($M = 10$) with $\psi = 90°$, 84°15' ($\cos^{-1} N/M$ weak crisis), 75°, 60°, 50°, 30° ($\cos^{-1} N/M$ strong crisis). The results are useful for study of processes in MHD machines including plasma accelerators as well as of quasi-steady astrophysical processes and the earth's magnetosphere. The author thanks A. A. Barmin and A. G. Kulikovskiy for attention and helpful discussion. Figures 6, references 13: 6 Russian, 7 Western.
[53-2415]

UDC 533.6.011.72

REGULAR REFLECTION OF STRONG SHOCK WAVE BY WEDGE SURFACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 6 May 80) pp 92-96

BOGATKO, V. I. and KOLTON, G. A., Leningrad

[Abstract] The problem of reflection of a strong shock wave by a wedge surface is solved analytically by the method of perturbations, a version resembling the method of a small parameter. A strong plane shock wave propagating through a stationary gaseous medium strikes an inclined plane. The boundary conditions for the corresponding system of vector equations describing the flow of gas and equations of the acoustic lines are impermeability of the surface and dynamic compatibility at the wave front after reflection. This boundary-value problem is simplified by the assumption that a shock wave traveling at a high velocity in a gas with the ratio of specific heats not much higher than unity remains close to the inclined plane after reflection. In this approximation, with the acoustic lines becoming circles, the solution yields the trajectory of the reflected wave through two vortex-free regions separated by a vortex region between two critical points, all trajectories of particles being rectilinear and passing through the center of acoustic circles. Numerical calculations have been made for wedge (inclination) angles β=30, 45, 60° and $k=c_p/c_v$ = 1.05, 1.1, or 1.2 in various combinations. The results reveal that regular reflection of a shock wave can occur over a wider range of wedge angles as the ratio of specific heats decreases. Figures 3, references 3 Russian.
[53-2415]

UDC 533.6.011.5

SEPARATION FLOW AT CONCAVE CONICAL WINGS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 12 Oct 81) pp 83-91

KRAVETS, V. V., Dnepropetrovsk, and SHVETS, A. I., Moscow

[Abstract] An experimental study of flow at conically concave delta wings was made, a particular concern being the pressure distribution and the lift force. Two sets of wing models with fixed sweepback angles, 73° (three models) and 78.7° (two models) respectively, were tested at a Mach number M = 3 in the supersonic wind tunnel at the Institute of Mechanics (Moscos State University). The angle of attack was varied from 0 to 15°. Taper and width of the concavity were defined by angles 17°, 17.5°, 18.5°; 11.3°, 11.7° and 90°, 102.5°, 113.5°; 90°, 108.5°. For control, a flat delta wing (taper angle 0°, width angle 180°) was added to each set. Pressure was measured with an inductive transducer through a pneumatic

commutator switch, with an rms relative error of ±3%. The data reveal a positive pressure jump across the cavity, except in the vicinity of the leading edges. They also reveal a drop of total pressure in the wake behind wings with zero angle-of-attack orientation. The results are interpreted in terms of interaction of the density jump and the boundary layer near the edges, with attendant separation, and interaction of viscous and nonviscous streams outside the pressure jump. Separation flow at concave wings, unlike that at flat or convex ones, is characterized by buildup of supersonic velocity within the separation zone between positive density jumps and by development of secondary separation flow. Figures 6, references 12: 7 Russian, 5 Western.
[53-2415]

UDC 532.529+532.59

PASSAGE OF WAVES IN FLUIDS THROUGH DAMPING INTERLAYERS AND THEIR INTERACTION WITH BARRIER

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 20 Oct 81) pp 53-58

LYAKHOV, A. G., Moscow

[Abstract] Interaction of a wave in a liquid-gas mixture with a barrier after passage through a porous solid medium is analyzed, taking into account the relaxation mechanism. A momentary compression of the liquid is assumed to occur under load, while the pressure in air bubbles is assumed to change adiabatically and deformation of air bubbles can be described by the viscous term in the Rayleigh-Lamb equation alone. The corresponding two equations of change of state, through deformation and relaxation respectively, together with the Euler equation and the equation of continuity in Lagrange variables constitute a closed system of equations which is solvable by the method of characteristics. Pressure transients have been calculated by this method for three forms of pressure wave (step of finite duration, step of finite duration, descending ramp of finite duration) in glycerin with air bubbles passing through a 3 mm thick porous damper before reaching an immovable solid barrier to which the damper adheres. The damper effectiveness, characterized by "damper action time" which shortens the wave-barrier interaction time, is found to be approximately proportaional to the volume fraction of air in the liquid within the 0.02-0.4 range and also approximately proportional to the thickness of the damping layer. Figures 5, references 7 Russian.
[53-2415]

UDC 532.526+534.29

EFFECT OF ACOUSTIC PERTURBATIONS ON FLOW STRUCTURE IN BOUNDARY LAYER WITH UNFAVORABLE PRESSURE GRADIENT

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Feb 83 (manuscript received 25 Jun 82) pp 48-52

DOVGAL', A. V. and KOZLOV, V. V., Novosibirsk

[Abstract] An experimental study was made concerning the effect of an acoustic field on flow in a laminar boundary layer with an unfavorable pressure gradient. Measurements were made in the T-324 low-turbulence wind tunnel at the Institute of Theoretical and Applied Mechanics (USSR Academy of Sciences). A boundary layer with a longitudinal pressure gradient was realized on a foil facing the air stream at a zero angle of attack along the channel axis. A dynamic loud-speaker in the diffuser emitted sound waves in the upstream direction, thus exciting acoustic velocity and pressure perturbations. The frequency of sound was varied over the 30-250 Hz range in 4 Hz bands and the sound pressure within the test zone was maintained within 90-105 dB or 20-30 dB above the integral-spectral ambient noise pressure, at a stream velocity V_∞ = 5.7 m/s. Both average and fluctuation velocity profiles were measured with a constant-temperature hot-wire anemometer. Correct analysis of separation and farther turbulent reattachment of the laminar boundary layer requires resolving the perturbations into acoustic and eddy components. The results reveal accordingly that two-dimensional eddy fluctuations, occurring at the acoustic frequency, become appreciable farther downstream where the pressure gradient becomes unfavorable and acoustic perturbations transform into Tollmin-Schlichting waves within the instability frequency range. Figures 5, references 8 Russian. [53-2415]

UDC 532.526.4

THREE-DIMENSIONAL TURBULENT BOUNDARY LAYERS AT BIELLIPTICAL BODIES IN STREAM OF COMPRESSIBLE GAS AT SOME ANGLE OF ATTACK

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Feb 83 (manuscript received 13 Nov 81) pp 39-47

ALEKSIN, V. A. and SHEVELEV, Yu. D., Moscow

[Abstract] Three-dimensional turbulent boundary layers at conical bodies with bielliptical cross section in a stream of compressible gas are analyzed on the basis of a system of partial differential equations in a curvilinear system of coordinates (ξ- longitudinal on the generatrix, χ- angle between meridional plane and upstream line of symmetry at given point, ζ- normal to the surface). These equations, one equation of continuity and two equations of momentum, contain geometrical coefficients and semiempirical effective transfer coefficients. The semiempirical model of transfer is a direct

extension of a two-dimensional model of turbulent transfer with fast changes in boundary conditions. The effective dynamic viscosity depends on the local Reynolds number and the local critical Reynolds number, the effective thermal conductivity depends on the two Reynolds numbers as well as on the local Prandtl number and the local eddy Prandtl number. The partial differential equations have been integrated numerically by the method of finite differences, with fourth-order accuracy in the normal coordinate. Pressure and velocity fields, including the separation zone and points of maximum thermal flux and maximum friction on the surface, have been determined in this way for a bielliptical conical body at angle of attack $\alpha = 20°$ in a supersonic air stream with $M_\infty = 20$. Figures 3, references 17: 10 Russian, 7 Western.
[53-2415]

UDC 532.526.4

INTERACTION OF TURBULENT BOUNDARY LAYER AND UPWARD DENSITY JUMP AT TRANSSONIC STREAM VELOCITIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Feb 83 (manuscript received 20 Oct 81) pp 32-38

VELICHKO, S. A. and LIFSHITS, Yu. B., Moscow

[Abstract] Interaction of a turbulent boundary layer at a plate and an upward density jump in a transsonic stream is analyzed by the asymptotic method, assuming a power-law rather than logarithmic profile of average velocity in the unperturbed boundary layer. The flow beyond the boundary layer is assumed to be laminar, implying that all correlation coefficients for the sought quantities (longitudinal and normal velocity components, density, pressure, temperature) are zero. Estimates are established, orders of magnitude, for increments of velocity components and pressure as a result of interaction at a Mach number M_∞ such that $M_\infty^2 - 1 = \varepsilon \ll 1$ and a relative thickness of the laminar sublayer $\delta = t/L \ll 1$. On this basis, with velocity components as well as pressure and density each sought in the form of a power series in the small parameter ε, the corresponding Navier-Stokes equations are solved for each of the three characteristic subregions of a boundary layer under a density jump of given intensity. The solution to second-order partial differential equations, obtained numerically with a conservative analog of relaxation, yields results which differ from those based on a logarithmic initial velocity profile but come close to exmperimental results with the largest discrepancy (3.5%) in pressure. Figures 2, references 17: 6 Russian, 11 Western.
[53-2415]

UDC 532.526.4

TURBULENT BOUNDARY LAYER AT PLATE WITH SUCTION AT VARIOUS ANGLES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA
in Russian No 2, Feb 83 (manuscript received 7 Aug 81) pp 27-31

DUNAYEVA, Ye. V., YEROSHENKO, V. M., KLIMOV, A. A. and KONDRAT'YEV, V. I.,
Moscow

[Abstract] An experimental study of turbulent boundary layers at porous or perforated plates with suction was made, for the purpose of determining the dependence of average and fluctuation velocity profiles on the angle between the direction of suction and the direction of the stream parallel to the plate. The purpose was to supplement already available data pertaining to low suction rates and nongradiental flow with data covering a wide range of suction rates (V_w/V_o = 0.002-0.047, V_w- normal component of velocity at wall, V_o- velocity of stream beyond boundary layer), negative and positive pressure gradients (with $K = \frac{\nu}{\rho} V^3 \frac{dP}{dX}$ ranging from $-2.2 \cdot 10^{-6}$ to $4.8 \cdot 10^{-6}$, ν- kinematic viscosity, ρ- density, P- pressure, X- longitudinal coordinate). Measurements were made at a Reynolds $N_R = 2 \cdot 10^5$ with suction angles α = 20°, 90°, and 160° relative to the direction of the stream. The velocity profiles were found to be flattest at α = 90° and most distorted at α = 20° (against the stream). Further evaluation of the data has yielded the momentum thickness δ^{**} of the boundary layer and the ratio of its displacement thickness to momentum thickness δ^*/δ^{**} (form factor), also the skin-friction coefficient Cf, as functions of the suction parameter $b_0 = 2F/Cf_0$ ($F = V_w/V_o$, Cf_0- friction coefficient in absence of suction). Figures 5, references 4 Russian.
[53-2415]

UDC (629.12.037.001.24:532.5)(084.2)

GRAPHS FOR DESIGN OF CAVITATING PROPELLER SCREWS

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 83 pp 11-12

KARPOV, A. B.

[Abstract] Graphs have been constructed for the design of propeller screws subject to cavitation. They are based on calcualtions made for 3-blade screws with maximum blade thickness $t_r = 0.05D$ at the root and $t_t = 0.0045D$ at the tip (D- outside diameter), with a convexo-convex blade profile where the radius of blade cross section is smaller than 0.3R (R- radius of screw) and concavo-convex everywhere else. The axis of abscissas is assigned to the diametral coefficient $K_d = v_p D\sqrt{\rho/P}$ (v_p- axial velocity of propeller, ρ- density of water, $P = R/z(1 - t)$, R- drag force of water, z- number of engines driving the propeller, t- suction coefficient). The axis of ordinates

is assigned to the relative forward displacement $\lambda_p = v_p/nD$ (n- rotational speed of propeller). Three intersecting families of curves are plotted: one for fixed values of the rotational coefficient $K_n = (v_p/\sqrt{n})\sqrt[4]{\rho/P}$ (hyperbolas) from 1.5 to 2.8, one for fixed values of the pitch ratio H/D from 1.0 to 2.2, and one for fixed values of the cavitation number from 0.20 to 1.30 respectively. From the coordinates of a given point on the graph are calculated the necessary screw diameter and driving power, taking into account propeller efficiency and shaft efficiency. Figure 1, references 5 Russian.
[44-2415]

UDC 532.547.4+621.928.93

TURBULENT FLOW OF AEROSOL IN ROTATING CHANNELS OF TURBOMACHINES

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 5, May 83 (manuscript received 23 Jun 82) pp 95-100

MEDVEDEV, G. G., VASILEVSKIY, M. V., KUROCHKIN, V. N, and ANISIMOV, Zh. A., Tomsk

[Abstract] Rotary separators are used for removal of suspended solid particles from the gas stream in rotating channels of a turbomachine. The aerosol is first precipitated and coagulated on the channel surfaces by action of centrifugal and Coriolis forces, then driven to the periphery of the runner for subsequent extraction. The effectiveness of this process in long narrow rotating channels depends on the turbulence of flow. For an evaluation of the separator performance, the turbulent flow of an aerosol in backward slanted rather than radial channels is described by the equation of a cyclon, analogous to that for centrifugal dust trap, with the appropriate boundary conditions. Attenuation of "external" turbulence along a channel and turbulent diffusion are accounted for by corresponding mass transfer coefficients, the latter determined from the condition of continuity for the gas and the momentum equation in accordance with the semiempirical theory. An expression is obtained for the efficiency of such a separator on this basis and another one is obtained from the equation of trajectories without turbulence, both involving geometrical parameters of the system and thus useful for design purposes. Comparative numerical data indicate the detrimental effect of turbulence and the range of parameters where this effect is most significant. The results obtained for a monodisperse aerosol can be generalized so as to apply a polydisperse aerosol such as cement dust, in the latter case the turbulence effect becoming negligible when the size distribution of particles is a log normal one. Figures 3, table 1, references 7 Russian.
[56-2415]

UDC 533.6.013.42

VIBRATIONS OF AND RADIATION FROM SHELL OF REVOLUTION UNDER HOOP LOAD

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 20 Jan 83) pp 184-193

VASIL'YEV, D. G. and GOL'DENVEYZER, A. L., Moscow

[Abstract] A closed shell of revolution with a meridian of arbitrary form is immersed in a compressible fluid, whereupon forces and moments harmonically varying in time are applied to it around a parallel. The resulting forced vibrations and radiated waves in the shell-fluid system are calculated from the equations of motion for the shell and the wave equation for the fluid as well as the condition of impermeability, with use of zero-moment differential operators and a moment differential operator in the theory of shells. The order of force, moment, and displacement harmonic is an additional parameter. The problem is first solved by integration of the homogeneous system of equations over the half-spaces on each side of the loaded parallel and subsequent collocation at that parallel with the proper discontinuities. The problem is also solved by an iterative asymptotic method which facilitates collocation on the shell surface as well as in the fluid. This is possible, because a normal hoop force or moment acting beyond the immediate vicinity of the shell produces, in the zeroth approximation, a pressure field which a force or moment acting directly on the fluid would produce. Estimates are made for the harmonic parameter of the order of unity, the lower bound for the frequency parameter being determined by adequate convergence of the asymptotic iterations and the upper bound of the frequency parameter based on applicability of the Dirichlet condition in accordance with the Helmholtz equation for this case. References 8: 7 Russian, 1 Western.
[55-2415]

UDC 531.8

EVALUATION OF ENERGY CHARACTERISTICS OF BIPEDAL WALKING AND RUNNING BY MODEL ANALYSIS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 13 Sep 82) pp 89-94

VELETSKIY, V. V. and BOLOTIN, Yu. V., Moscow

[Abstract] The energy characteristics of bipedal motion on a horizontal ground are evaluated with the aid of the mathematical apparatus for analyzing the dynamics of a free material point, in this case the center of mass. The equations of its motion are formulated differently for running and for walking. In the case of running the duration of contact between foot and ground is assumed to be so short as to make the flight duration almost identical to the step duration. In the case of walking, with the object assumed to be resting on one leg at every instant of time, two modes are considered. The first mode of walking is with the center of mass moving as a pendulum. The second mode of walking is with the center of mass remaining at a constant given altitude above ground. The relations for energy consumption per unit distance or per unit time, respectively, indicate ways to optimize the motion for maximum economy in each case, the variable parameter being the length of step. After first disregarding the dynamics of leg transfer in the first approximation, the analysis continues with the dynamics taken into account and then with impact effects also corrected for. Numerical data are given and their accuracy is estimated, for specific models of bipedal motion such as a "statistically" average man and a tyranosaurus, also a hypothetical bipedal machine weighing 30 t and moving at a speed of 30 km/h. Figure 1, references 4: 3 Russian, 1 Western.
[55-2415]

UDC 531.8

TREATMENT OF WALKING AS CONTROLLABLE SELF-EXCITED OSCILLATIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 30 Jun 82) pp 81-88

NEYMARK, Yu. I., Gorkiy

[Abstract] Walking is treated as controllable oscillatory motion of a bipedal mechanism. Each cycle is subdivided into two phases, first one leg swinging over with other leg as pivot and then switching of legs, each leg being simulated by a two-bar kinematic linkage. This motion is analyzed in the Lagrangian formalism, with the jerk of the pivot leg prior to switching regarded as both self-excitation and means of speed control. The objects of control are angular displacement and velocity of the swinging leg, running being excluded from consideration on account of its being a different process

with three phases per cycle, also pace stabilization and smoothness. The ground is assumed to be hard, a soft ground constituting an extreme case without jerking. Figures 6, references 14: 13 Russian, 1 Western.
[55-2415]

UDC 531.8

SUBHARMONIC VIBRATIONS OF ROTOR MOUNTED IN ROLLING BEARINGS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 1 Feb 83) pp 77-80

MOVCHAN, A. V. and FILATOV, V. V., Moscow

[Abstract] An experimental study of subharmonic vibrations of a rotor was made, with a gyromotor rotor mounted in ball bearings so as to ensure very low friction. The electric gyromotor was a 3-phase synchronous one with voltage and frequency control. The rotor speed was measured with a stroboscopic tachometer for precise speed control and recording, its vibrations were measured by means of a piezoelectric accelerometer with the sensitivity axis in the radial plane of one bearing. The accelerometer readings, twice integrated and amplified, were fed to a digital computer for harmonic analysis. Each of the five such GMS-9 motors for this experiment was mounted in 1000095 ball bearings with stationary inner race and rotating outer race. The vibration spectra of all motors reveal two dominant frequencies, indicated by sharp amplitude peaks. These frequencies correspond respectively to the speed of the rotor ω and to the speed of the bearing separator ω_s, the ratio of these speeds remaining $\omega_s/\omega = D/(D + d) = 0.61$ in all tests (D and d diameters of outer and inner bearing race, respectively, at the contact line in the groove). The authors thank M. Yu. Shatalov and N. Ye. Isikov for assistance in the experiment and with processing of the data. Figures 7, references 2 Russian.
[55-2415]

UDC 531.8

STABILITY OF STEADY MOTION OF PLANAR BODY IN FIELD OF CENTRAL FORCE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 10 Jan 83) pp 71-76

ZHURAVLEV, V. F., Moscow

[Abstract] A problem of a planar body moving in its plane is considered, namely attraction of such a body to a stationary point O' outside by a force applied to it at a point O other than its center of mass G. The plane motion of this body is analyzed, with the fixed distance (eccentricity) $e = |OG|$ as

parameter. The force f(r) is assumed to be a potential one, a function of the variable distance r = |00'|. The corresponding equations of motion are first put in the Lagrangian form and the famliy of steady-state solutions is obtained, whereupon the amplitude-frequency characteristic and the stability region are established for a not necessarily linearly elastic body. As a special case is considered a "convex from below" force. The stability of motion is further analyzed in the Hamiltonian formulation, after an appropriate change of generalized coordinates. The roots of the characteristic equation are tested for real parts and stability criteria are established on the basis of Lyapunov's first theorem or the Arnold-Moser theorem wherever applicable. Zero eccentricity is also considered as a special case. Figures 3, references 7 Russian.
[55-2415]

UDC 531.55:521.2

STABILITY OF PERIODIC OSCILLATIONS OF ALMOST AXISYMMETRIC SATELLITE IN PLANE OF ELLIPTICAL ORBIT

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 20 Dec 82) pp 41-50

PETROV, A. L., SAZONOV, V. V. and SARYCHEV, V. A., Moscow

[Abstract] A solid satellite of almost axisymmetric form, but with an anomaly of its center of mass as independent variable, is considered moving in an elliptical Kepler orbit. Its periodic oscillations in the plane of that orbit, caused by the gravitational torque, are analyzed for stability. The corresponding system of equations of motion has the property that, if its solution satisfies the condition of plane motion at some initial anomaly of its center of mass, it will satisfy this condition at every other magnitude of the anomaly. The 2π - periodic solution to the corresponding boundary-value problem has been obtained by numerical methods. The stability region is established analytically as that for two independent linear systems, the two variational equations describing them reduced to an equivalent single one. After the dependence of the coefficients in the characteristic equation on e and μ (e- eccentricity of the ellipse, $\mu = 3(C - A)/B$, A,B,C moments of inertia with respect to the central principle axes x,y,z) has been determined, existence and uniqueness of the 2π - periodic solution are proved on the basis of Poincare's theorem. It can also be proved by Poincare method that this solution will be determinate when those coefficients are not equal to unity. Figures 5, references 7: 5 Russian, 2 Western.
[55-2415]

UDC 531.39

INTEGRABLE EQUATIONS OF MOTION BY INERTIA FOR TWO BODIES COUPLED THROUGH SPHERICAL HINGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 4, Apr 83 (manuscript received 20 Sep 82) pp 26-31

LESINA, M. Ye. and KHARLAMOV, P. V., Donetsk

[Abstract] Motion by inertia of two coupled bodies is considered, specifically of a housing and a flywheel with a mass distribution according to a Lagrange gyro and with a coupling through an ideal spherical hinge. The system is assumed to be conservative. One class of solutions is obtained for the case of zero momentum, with the energy integral splitting into three invariant equalities. Another class of solutions is obtained for the case of a nonzero momentum vector which remains constnat in space but varies in the two bases, with the six differential equations in the system of six differential and six algebraic ones also integrable. The positive-definiteness of kinetic energy leads in this case to two variants: 1) $\mu = 0$, $k_0 = -k$; 2) $\mu = 1/2\pi$, $k_0 = k$ (μ- integration constant, $k = n/g$ and $k_0 = n_0/g$ momentum ratios for housing and flywheel respectively).
References 28: 27 Russian, 1 Western.
[55-2415]

UDC 539.3

EXPERIMENTAL STUDY OF BEHAVIOR OF CYLINDRICAL SHELLS WITH LUMPED MASSES UNDER DYNAMIC EXTERNAL PRESSURE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 3, Mar 83 (manuscript received 23 Jun 81) pp 187-191

ANDREYEV, L. V., ANTSIFEROV, A. V., DUBOVIK, O. M. and PAVLENKO, I. D., Dnepropetrovsk

[Abstract] An experimental study was made of circular cylindrical shell, smooth and with attached discrete masses, under pulses of uniformly distributed external pressure. The shells were made of 0.24 mm thick cold-rolled Kh18N9-n stainless (chromium-nickel) steel sheet with a modulus of ealsticity $E = 2 \cdot 10^5$ MPa and a yield strength $\sigma_{0.2} = 8 \cdot 10^2$ MPa, and produced by wrapping around a rigid drum for precision lap spot-welding. One group of such shells was dynamically loaded with an electromagnetic device, after having been electrolytically coated with a 0.05 mm thick layer of copper, and tested with pressure pulses producing axisymmetric flexural vibrations with a period of $0.8 \cdot 10^{-4}$ s. Another group was dynamically loaded with an electrohydraulic device and tested with pressure pulses producing axisymmetric flexural vibrations with a period of $0.9 \cdot 10^{-4}$ - $1.6 \cdot 10^{-3}$ s. Pulses of three different durations (90 μs, 120 μs, 0.7 ms) were applied to shells in the first group, pulses of two different durations

(90 μs, 0.7 ms) were applied to shells in the second group. Steel balls of various sizes were successively welded onto the shells at the center section variously spaced around the circumference, whereupon the shells were tested again in accordance with the same criterion of stability loss. The experimental data have been evaluated in the form of "dependence of critical load pulse (relative to that for a smooth shell) on magnitude of attached mass (relative to that of smooth shell)", also in terms of the "amplification factor" representing the ratio of maximum depth of residual depression to maximum measured initial deflection. The results reveal that the critical load is lower for a shell with attached mass than for a smooth shell and that a weaker pulse will produce a depression of the same residual depth in a shell with attached mass. Figures 7, references 4: 3 Russian, 1 Western.
[54-2415]

UDC 533.6.013.42

EFFECT OF PRESSURE WAVE ON CYLINDRICAL SANDWICH SHELL IMMERSED IN COMPRESSIBLE FLUID

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 3, Mar 83 (manuscript received 30 Jul 81) pp 157-165

POZHUYEV, V. I., Zaporozhye

[Abstract] An axisymmetric pressure wave propagates at constant velocity along the inside surface of a cylindrical sandwich shell of infinite length immersed in an ideal compressible fluid. The steady-state response of that shell is calculated from the partial differential equations of motion for both sheaths, the vector equation of motion for the filler between them, and the wave equation for the fluid. The sheaths are so thin that they can be assumed to make contact with the filler and with the fluid along their median surfaces. With the corresponding boundary conditions, using a system of coordinates fixed to the shell and one moving with the pressure wave, the problem is solved by a Fourier integral transformation of the sought functions and subsequent inverse transformation yielding the shell response in terms of displacement and stress. Specific solutions are obtained for subseismic (pressure wave slower than shear wave in filler) and superseismic (pressure wave faster than tension-compression wave in filler) as well as intermediate transseismic (pressure wave faster than shear wave but slower than tension-compression wave) cases with either rigid or sliding contact between sheaths and filler. Special cases are double-layer shells without inner sheath or without outer sheath respectively and a shell without both sheaths (filler alone of thick-wall single-layer shell) under propagating internal pressure. Numerical results have been obtained for shells with steel sheaths and "hard" or "soft" (polyvinyl chloride) filler in water. Figures 6, table 1, references 8: 7 Russian, 1 Western.
[54-2415]

UDC 533.6

EFFECT OF ELASTICALLY SUSPENDED MASSES ON STABILITY OF ELASTIC PANELS IN SUPERSONIC STREAM

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 3, Mar 83 (manuscript received 23 Jun 82) pp 149-156

BOLOTIN, V. V. and SIMONOV, B. P., Moscow

[Abstract] The aerodynamic problem of stability is solved for a horizontal plane panel mounted into a perfectly rigid and infinitely large frame. Its top surface is swept by a supersonic stream occupying the upper half-space and flowing at an unperturbed velocity parallel to that surface. The panel is treated as a thin elastic plate deformable according to Kirchhoff's classical theory. Into the lower half-space, assumed to be a vacuum, are suspended from the panel at discrete points viscoelastic bodies (viscous element and elastic element in parallel) of three kinds: 1) lumped point-masses suspended from one point each; 2) elongated line masses suspended from two points each; 3) bodies with all three dimensions of the same order of magnitude. The equation of vibrations for the panel, taking into account perturbations of aerodynamic pressure on it and of forces on the suspended elements, is supplemented with one equation of motion for a suspended point-mass or with two equations of motion for a suspended line-mass. Small perturbations and continuous potential flow are assumed. Integration of the flow function by parts, with evaluation of quadruple integrals, yields the aerodynamic lift and drag coefficients. The linearized Cauchy-Lagrange integral yields the perturbed pressure. Approximations of quasi-steady motion and steady motion are checked at moderate velocities of supersonic air flow and moderate frequencies of panel vibration, at which the "piston" theory becomes inapplicable. An analysis of panel stability on the basis of those equations and their solution reveals the effect of suspended masses. The equations have been solved in Gaussian quadratures on a YeS-1033 Unified System computer by the method of a moving boundary, and the effect of suspended elements on the stability of such a panel has been evaluated for the case of a single suspended point-mass. Figures 6, references 6: 4 Russian, 2 Western.
[54-2415]

UDC 539.3

THREE-DIMENSIONAL STRESSED STATE OF LONGITUDINALLY CORRUGATED ELASTIC CYLINDERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 3, Mar 83 (manuscript received 23 Jun 82) pp 55-62

NEMISH, Yu. N. and CHERNOPISKIY, D. I., Kiev

[Abstract] The three-dimensional stressed state of an elastic hollow basically circular cylinder with longitudinal corrugation of both surfaces

is calculated, assuming that the inside radius and the outside radius vary with equal amplitudes as the same continuous differentiable function of the circumferential coordinate. Eight possible variants of such corrugation are considered, two cophasal and two antiphasal combinations, including the special cases of either a smooth inside surface or a smooth outside surface. The form of the lateral surfaces and the end constraints are assumed to admit Taylor expansion of displacements and stresses in the vicinity of a surface. A single notation with differential operators is used for describing the boundary conditions in every order of approximation. The solution of the corresponding boundary-value problem involves evaluating Bessel functions and MacDonald functions of an imaginary argument, which is unwieldy but can be simplified by seeking the solution in terms of ratios of those functions. The algorithm has been programmed for a BESM-6 high-speed computer. It is demonstrated on a cylinder with smooth outside surface and sinusoidally, trapezoidally, or triangularly corrugated inside surface under internal pressure. Numerical results have been obtained by the method of boundary shape perturbation. Figures 3, tables 4, references 10: 9 Russian, 1 Western.
[54-2415]

UDC 539.43

ELASTOPLASTIC DOUBLE-WALL SHELLS UNDER INTRICATE NONISOTHERMAL LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 83
(manuscript received 10 Mar 82) pp 106-109

SIVCHIKOV, B. Ye. and SOKOLOVA, I. N., "Red Banner" Institute of Military Engineering

[Abstract] The stressed and strained state of an elastoplastic axisymmetric thin double-wall shell under an intricately varying nonisothermal load is calculated, with load and deflection history taken into account. The walls are assumed to be both either rigidly clamped or freely supported, but each differently heated. The theory of plastic deformation and a simple piecewise-linear variant of the Trask-St.Venant model are used for analysis. The corresponding boundary-value problem has been solved for a shell with variable-thickness (tapering) outer wall made of a titanium alloy and uniform-thickness inner wall made of a bronze alloy. Three different loading programs were considered: I) raising the pressure, then heating both walls to their respective operating temperatures, then lowering the pressure with cooling; II) raising the pressure, then heating first the outer wall and then the inner wall to their respective operating temperatures, then lowering the pressure with cooling; III) heating both walls to their respective operating temperatures, then raising the pressure, then lowering the pressure with cooling. The attendant plastic elongation-contraction cycles in both principal directions, axial and circumferential, were determined in each case. Figures 5, references 3: 1 Russian, 2 Western.
[47-2415]

UDC 539.4:621.876

STRESSED AND STRAINED STATE OF CYLINDRICAL SHELLS REINFORCED WITH HOOPS

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 83
(manuscript received 30 Mar 82) pp 102-106

TATARINOV, A. P., Institute of Applied Mathematics and Mechanics,
UkSSR Academy of Sciences, Donetsk

[Abstract] The problem of reinforcing a cylindrical shell for static strength with elastic stiffner hoops is treated on the basis of the corresponding discrete-continual model, assuming the hoops to be closely spaced. The total state of stress is resolved into a principal zero-moment component and an additional nonzero-moment one. The system of six homogeneous equations for the zero-moment shell with internal forces is simply integrated. The solution of the resolvent equation for edge effect is expressed in terms of Krylov functions. The conditions of coupling between hoops and sheath are established taking into account compatibility with respect to strains as well as kinematic factors. The system of four differential equations of equilibrium for a hoop is reduced to a system of eight algebraic equations for each Fourier component, conveniently expressible in matrix form. A numerical solution has been obtained on a YeS-1033 Unified System computer for design of an MK-3.25x4 sheave of a hoisting machine with four ropes. Figures 4, references 7 Russian.
[47-2415]

UDC 536.24.021

RESIDUAL STRESSES IN LONG DOUBLE-LAYER CYLINDER UNDER NONSTEADY COOLING

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 83
(manuscript received 19 May 82) pp 98-101

BELOUSOV, V. Ya., Ivano-Frankovsk

[Abstract] The problem of residual stresses in a solid double-layer nonhomogeneous circular cylinder is solved for the case where the temperature is a function of both the radial distance from the axis and of time. The materials of the cylinder are assumed to be ideally elastoplastic of the Trask kind, the temperature dependence of their mechanical and thermophysical properties is disregarded, and the mechanical contact between layers is assumed to be ideal. The cylinder is cooled from a uniform initial temperature to a constant ambient temperature. Strains and displacements are calculated from the corresponding equations for the case of an axial stress lower than the tangential stress but higher than the radial stress. The transition between elastic and plastic deformation is established in terms of critical temperature difference between cylinder surface and ambient medium as well as corresponding maximum quasi-static stresses,
References 6 Russian.
[47-2415]

UDC 531.74

ORIENTATION AND CALIBRATION OF THREE-DIMENSIONAL TACHOMETER WITH AID OF AVAILABLE ANGLE DATA

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 3, Mar 83 (manuscript received 14 Dec 82) pp 19-23

TKACHENKO, A. I., Kiev

[Abstract] The problem of determining the spatial orientation of an "instrument" trihedron is solved for such a trihedron with tis angular velocity measured continuously and its initial orientation known approximately. The readings of angular velocity are assumed to contain a small additive error representable as a linear combination of a finite number of known functions with unknown coefficients, the latter to be determined along with the parameters defining the orientation of the instrument. The components of the true velocity vector are assumed to be continuously differentiable with respect to time almost throughout the entire measuring time period. This problem is solved with the aid of available data on the angular motion of another trihedron with fixed but unknown orientation relative to the instrument. The solution is analyzed for accuracy and a procedure for refining the orientation of the orthonormalized instrument vector basis is demonstarted on the case where the velocity reading error is $\Delta\omega_E = c_1 + c_2 t + c_3 t^2 + c_4 \Omega(\omega_E)$ (c_1, c_2, c_3, c_4 unknown coefficients, t- time, Ω- angular displacement as functions of angular velocity ω_E), with the three components of angular velocity read during five successive equally long time intervals. References 5 Russian.
[54-2415]

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